# PHYTOTOXICOLOGY SECTION INVESTIGATION IN THE VICINITY OF THE BRUCE NUCLEAR POWER DEVELOPMENT, THE PICKERING NUCLEAR GENERATING STATION AND THE DARLINGTON NUCLEAR GENERATING STATION, IN OCTOBER, 1989

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# PHYTOTOXICOLOGY SECTION INVESTIGATION IN THE VICINITY OF THE BRUCE NUCLEAR POWER DEVELOPMENT, THE PICKERING NUCLEAR GENERATING STATION AND THE DARLINGTON NUCLEAR GENERATING STATION, IN OCTOBER, 1989

Report prepared by:
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Air Resources Branch

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## 1 Background

The Phytotoxicology Section, Air Resources Branch is a participant in the Pickering and Bruce Nuclear Contingency Plans. The Phytotoxicology Emergency Response Team is responsible for collecting vegetation samples in the event of a nuclear emergency at any of the nuclear generating stations in the province. As part of it's responsibility the Phytotoxicology Section collects samples around the nuclear generating stations for comparison purposes in the event of an emergency. Because of the limited frequency of sampling, the data from the surveys are not intended to be used as part of a regulatory monitoring program. These data represent an effort by the MOE to begin to establish a data base of tritium concentrations in vegetation.

The Phytotoxicology Section has carried out seven surveys in the vicinity of Ontario Hydro nuclear generating stations since 1981. Surveys were conducted for tritium in snow in the vicinity of Bruce Nuclear Power Development (BNPD), February, 1981 (1), tritium in cell-free water of white ash in the vicinity of BNPD, September, 1981 (2), tritium in snow in the vicinity of BNPD, March, 1982 (3), tritium in tree sap in the vicinity of BNPD, April, 1982 (3), tritium in tree sap in the vicinity of BNPD, April, 1984, tritium in the cell-free water of white ash in the vicinity of BNPD, September, 1985 (4), and tritium in cell-free water of grass in the vicinity of Pickering Nuclear Generating Station (PNGS), October 1986 (5). In all cases a pattern of decreasing tritium levels with increasing distance from the stations was observed.

In October 1989, assessment surveys were conducted around Bruce Nuclear Power Development, the Pickering Nuclear Generating Station and the new Darlington Nuclear Generating Station (DNGS). The purpose of these surveys was to provide baseline data for tritium in cell-free water of grass at all three locations at the same time of year. As none of the reactor units at DNGS had been brought on line at the time of the survey, this data was to be considered pre-operational or background data for DNGS. However, the Tritium Removal Facility was under commissioning at the time of the survey.

## 2 Methods

On October 25, 1989 R.D. Jones and D.S. Harper of the Phytotoxicology Section collected grass samples at nine sampling locations in the vicinity of the Darlington Nuclear Generating Station (see Figure 1). Stations 1, 2 and 8 were classed as rural agricultural and the rest of the stations were either rural industrial or urban.

Twelve grass samples were collected in the vicinity of the Pickering Nuclear Generating Station on the same date. Seven of the PNGS sampling locations were the same as used in the 1986 survey. Five additional stations were added to better delineate the zone of influence and one of the original stations was eliminated (see Figure 2). All of the PNGS sample locations, with the possible exception of station 11, were classed as urban.

On October 27, 1989 R.D. Jones and M. Dixon collected grass samples at 13 locations in the vicinity of the Bruce Nuclear Power Development. All of these samples were collected at locations used in previous snow or vegetation surveys (see Figure 3). All 13 stations were classed rural, with stations 8, 10, 13, 14, 21 and 22 collected adjacent to agricultural fields.

While it was not possible to collect the same grass species at each location in the three surveys, all of the grass collected was uncut, broad leaf type grass. All of the samples were green, mature grass with less than ten percent dry or dead leaves.

The samples were collected using standard Phytotoxicology sampling techniques (6). The samples were sealed in 500 ml air tight plastic sample bottles and stored in a refrigerator. The samples were delivered to the Ontario Ministry of Labour, Health and Safety Support Services Branch, Radiation Protection Service for analysis of tritium in cell-free water. Cell-free water was extracted from the grass tissue by azeotropic distillation. The extract was mixed with Dimilume scintillation cocktail and counted on the Packard 300C liquid scintillation counter.

**Figure 1:** Sketch Map of the Vicinity of the Darlington Nuclear Generating Station Showing the Approximate Locations of Grass Samples Collected for Tritium Analysis on October 25, 1989

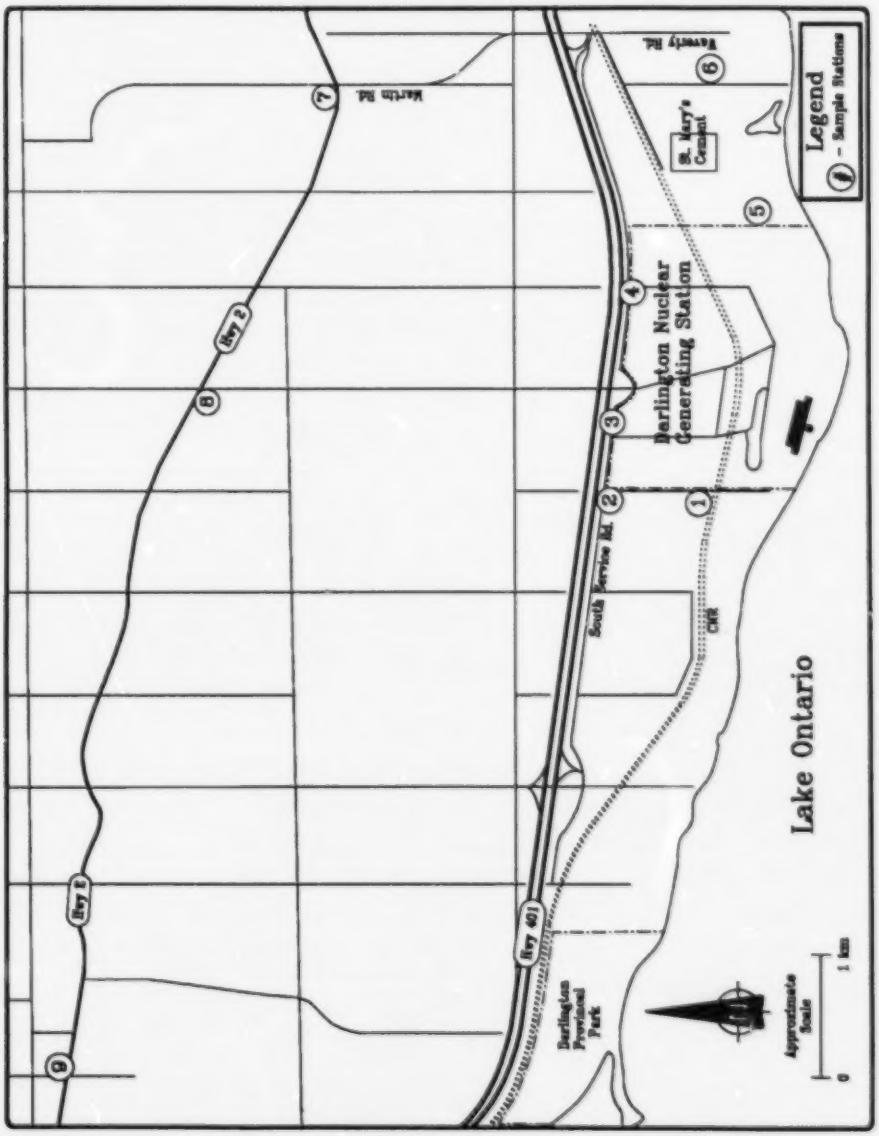


**Figure 2:** Sketch Map of the Vicinity of the Pickering Nuclear Generating Station Showing the Approximate Locations of Grass Samples Collected for Tritium Analysis on October 25, 1989

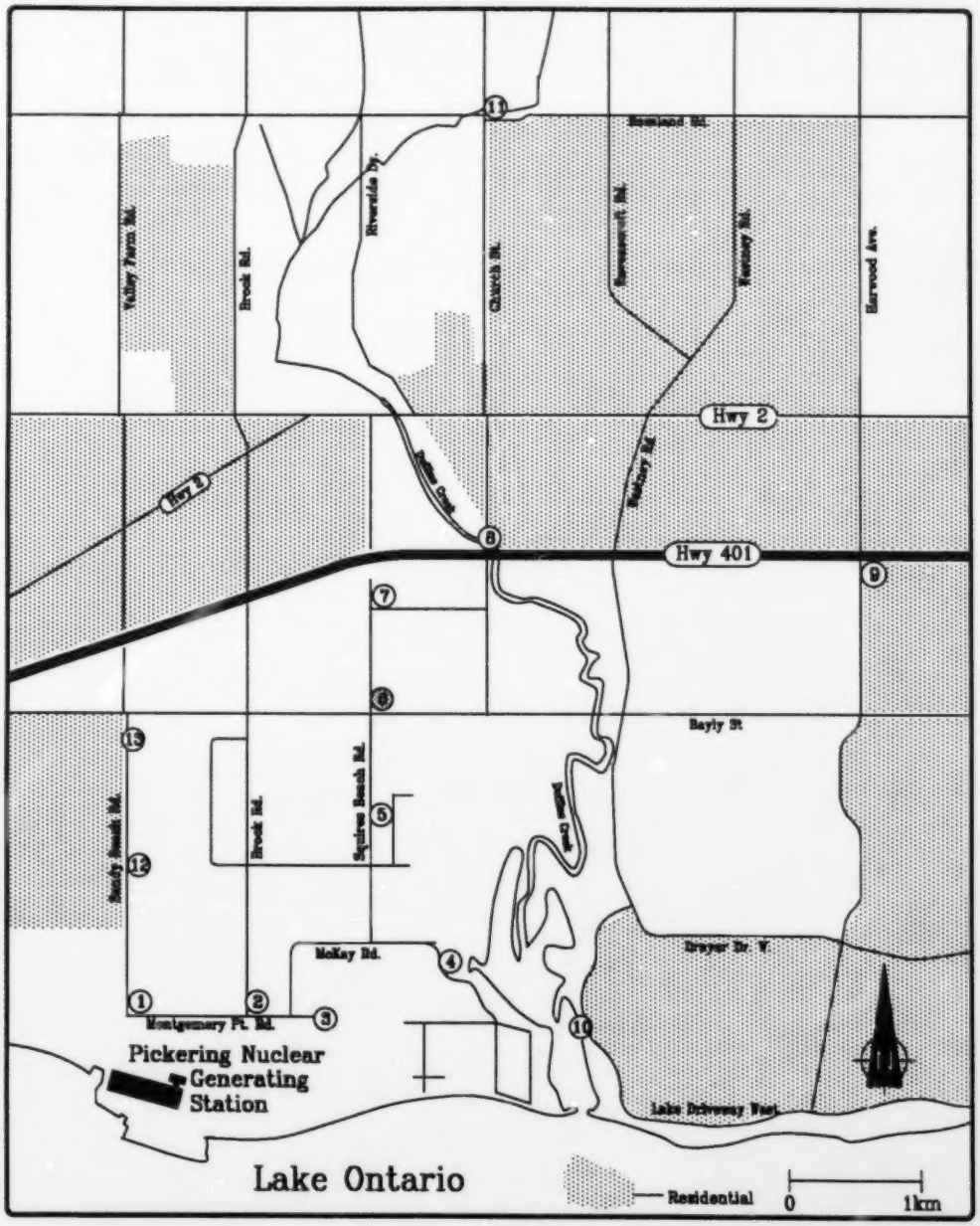
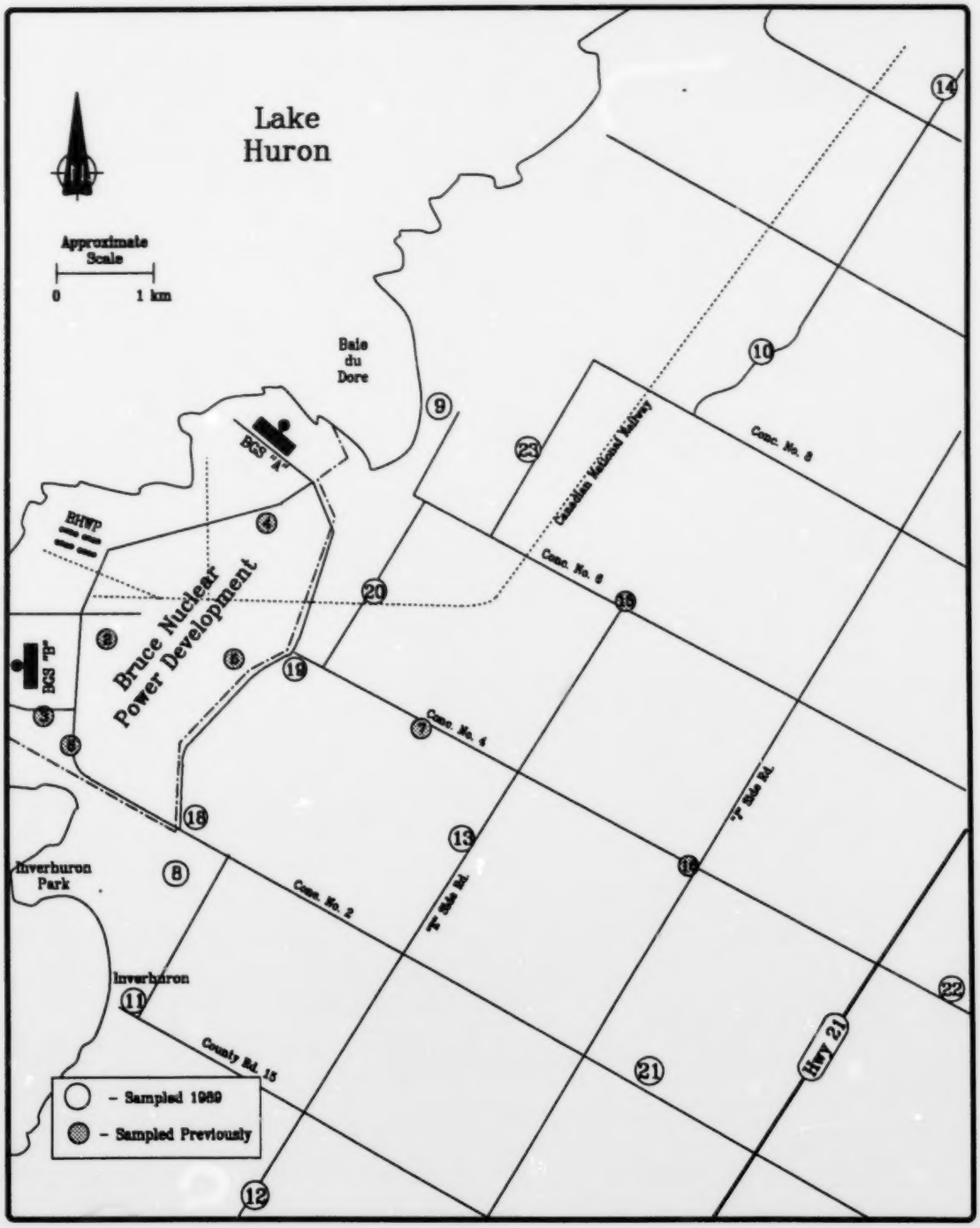


**Figure 3:** Sketch Map of the Vicinity of the Bruce Nuclear Power Development Showing the Approximate Locations of Grass Samples Collected for Tritium Analysis on October 27, 1989



## 3 Results

The results for the 1989 DNGS survey are given in Table 1. The result for the 1989 PNGS survey are given in Table 2. The results from the 1986 PNGS survey are also given in Table 2 for comparison purposes. The results for the 1989 BNPD are given in Table 3. The results from all of the previous tritium surveys for the BNPD are also included in Table 3 for comparison purposes. All of the tritium results are expressed as Becquerels per litre (Bq/L) of cell-free water extract. Results previously reported in nCi/L have been converted to Bq/L by multiplying by 37 (7). The reported detection limit for the 1989 results was 30 Bq/L while the detection limit for previous surveys was 15 Bq/L.

**Table 1:** Tritium Activity in Cell-Free Water Extracts from Grass Collected in the Vicinity of the Darlington Nuclear Generating Station, October 25, 1989

| Sampling Site | Tritium Bq/L |
|---|---|
| 1 | <30 |
| 2 | <30 |
| 3 | <30 |
| 4 | 180 |
| 5 | 37 |
| 6 | <30 |
| 7 | <30 |
| 8 | <30 |
| 9 | <30 |

**Table 2:** Tritium Activity (Bq/L) in Cell-Free Water Extracts from Grass Collected in the Vicinity of the Pickering Nuclear Generating Station, October 31, 1986 and October 25, 1989

| Sampling Site | Grass 1986 | Grass 1989 |
|---|---|---|
| 1 | 3,800 | 50,000 |
| 2 | 810 | 7,700 |
| 3 | 370 | 5,000 |
| 4 | 240 | 3,200 |
| 5 | 220 | 7,800 |
| 6 | 100 | - |
| 7 | 100 | 8,100 |
| 8 | 76 | 5,600 |
| 9 | - | 4,900 |
| 10 | - | 1,100 |
| 11 | - | 1,600 |
| 12 | - | 1,500 |
| 13 | - | 930 |

**Table 3:** Tritium Activity (Bq/L*) in Cell-Free Water Extracts from Grass, White Ash Leaves, Tree Sap and Snow Collected in the Vicinity of the Bruce Nuclear Power Development, 1981, 1982, 1984, 1985 and October 25, 1989

| Sampling Site | Snow 1982 | Tree Sap 1982 | Tree Sap 1984 | White Ash 1981 | White Ash 1985 | Grass 1989 |
|---|---|---|---|---|---|---|
| 2 | - | - | - | 648 | 180 | - |
| 3 | - | - | - | 152 | 86 | - |
| 4 | - | - | - | 403 | 140 | - |
| 5 | 360 | 360 | 310 | 333 | 85 | - |
| 6 | - | - | - | 94 | 61 | - |
| 7 | 260 | 260 | 300 | 78 | 48 | - |
| 8 | 270 | 260 | 190 | 63 | 48 | <30 |
| 9 | 240 | 240 | 1000 | 93 | 200 | 82 |
| 10 | 160 | 160 | 180 | 51 | 110 | <30 |
| 11 | 92 | 93 | 110 | 52 | 23 | <30 |
| 12 | - | - | 43 | 36 | 24 | <30 |
| 13 | 200 | 200 | 110 | 109 | 31 | <30 |
| 14 | 85 | 85 | 120 | 36 | 56 | 120 |
| 18 | - | - | - | - | 43 | 63 |
| 19 | 470 | 470 | 360 | - | - | 90 |
| 20 | - | - | 520 | - | - | 84 |
| 21 | - | - | - | - | 19 | <30 |
| 22 | - | - | - | - | <15 | <30 |
| 23 | - | - | 350 | - | - | - |

* - 1982 results were originally reported as nCi/L. Converted to Bq/L by multiplying by 37.

## 4 Discussion

Unlike many traditional air pollutants, tritiated water in plant tissues is known to be transient in nature, with residency time being variable and relatively short in duration (days). On the basis of this behavior, atmospheric tritium loadings are considered very mobile and should leave the plant tissue fairly rapidly when the source of tritium is removed. As a result, the data reported herein should be viewed as indicative of atmospheric emissions activities of a recent nature, relative to the sampling date.

### 4.1 Darlington Nuclear Generating Station

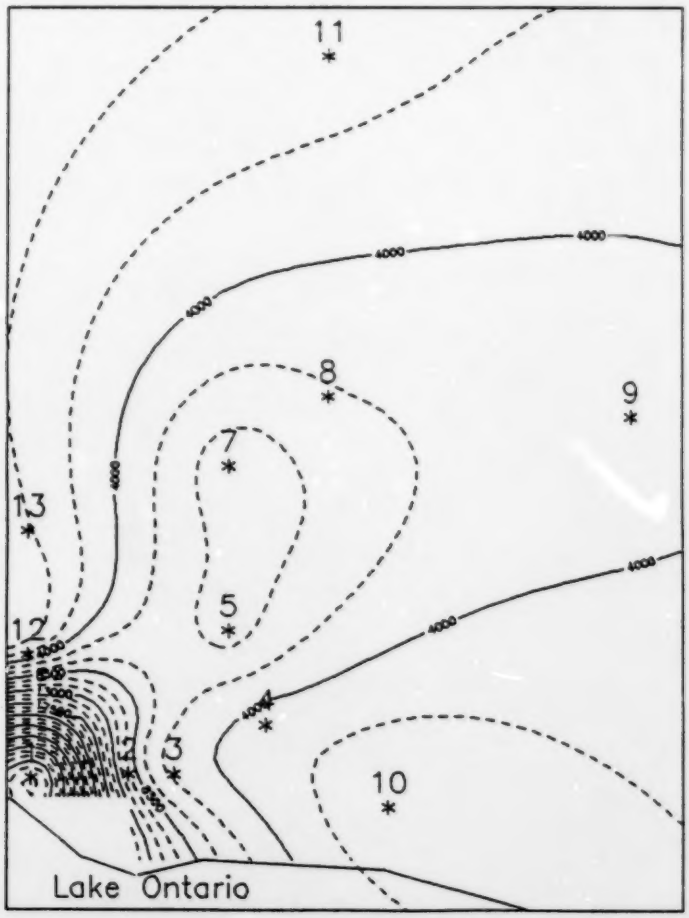
The results for tritium in grass around the Darlington Nuclear Generating Station are largely as would be expected. The majority of the samples are below the detection limit of 30 Bq/L. The two exceptions were at stations 4 and 5 located at the northeast and east boundaries of the station property. While above the detection limit, the levels at these two stations are still low compared to results collected around PNGS. The fact that results above background were detected indicates that there may have been emissions from one of the units during testing and/or start-up or from the Tritium Removal Facility (TRF). These emissions were confirmed recently in discussion with Ontario Hydro. Emissions originated during the commissioning of the TRF.

## 4.2 Pickering Nuclear Generating Station

While the pattern of tritium in grass around the Pickering Nuclear Generating Station in 1989 was similar to the 1986 results, the levels and the size of the area affected were significantly larger. The levels in 1989 were 8.5 to 80 times higher than those for the same locations collected in 1986. The results were also higher than any of the results from the 1989 Bruce Nuclear Power Development survey or any previous sampling results in the BNPD area.

The results show a pattern of elevated tritium decreasing with distance from the station in a northeast direction (see Figure 4). The levels appear to drop off more rapidly in the east, north and west directions. It is impossible to determine the full extent of the contamination as background levels were not observed at any location. Based on the earlier discussion of the mobility of tritium, the results suggest that a release had occurred near the time of the survey. Since tritium releases display significant short-term variations (several magnitudes) during routine operation, and the concentration at any point in the environment also depends upon the meteorological conditions at the time, it is not unexpected that comparison of single samples could also show a wide variation.

**Figure 4:** Contour Map Showing the Estimated Pattern of Tritium in Grass in the Vicinity of the Pickering Nuclear Generating Station on October 25, 1989




Contours were generated using the program "Surfer" ver. 3.0 ,Golden Software Inc.
Contour Interval of 1500 Bq/L of cell-free water extract.

## 4.3 Bruce Nuclear Power Development

The results for tritium in grass around the Bruce Nuclear Power Development are similar in pattern to results that had been collected for white ash foliage, tree sap and snow in previous years. With the exception of station 14, detectable levels of tritium were limited to the perimeter of the BNPD property. The levels were generally lower in 1989 but in the same order of magnitude compared to what had been observed for these same stations in previous years. It is not possible to determine if the differences are due to receptor (species/media) types, climatic (wind pattern) variation or to differences in emissions. A collection of grass along with tree foliage from a number of different species at the same sites and at the same time would provide useful information as to whether there are differences between receptors.

## 4.4 Report Review

A draft of this report was reviewed by both Atomic Energy Control Board (AECB) and Ontario Hydro. AECB stated that continuous tritium emissions are expected from Ontario's nuclear generating stations. In 1989, the annual average tritium emission from Pickering was about 0.1% of the Derived Emission Limits (DEL), based on Ontario Hydro monitoring data, and in 1986 it was about 0.07% of the DEL. A DEL is a derived upper limit for a single radionuclide from a single facility for airborne and liquid effluents, and is such that compliance with it will give reasonable assurance that the annual dose limit is not exceeded. Based on published Ontario Hydro reports (8,9) there has been an increase in annual tritium emissions to atmosphere of 2.7 fold between 1986 and 1989. The increase in the grass sampling results are not proportional with the reported increase in tritium emissions between 1986 and 1989. This probably reflects the limited frequency of grass sampling in both 1986 and 1989, possible meteorological variation at the time of sampling, and the fact that normal variation in grass tritium concentrations have not yet be established.

# 5 Summary

Phytotoxicology assessment surveys were conducted in the vicinity of the three Ontario Hydro Nuclear Generating Stations in October, 1989. These surveys represent an effort by the MOE to begin to establish a database of tritium concentrations in vegetation to assist in participation on Nuclear Contingency sampling programs.

The levels of tritium in grass at the Bruce station were similar to levels from previous studies. The levels at the Darlington station confirmed a minor tritium release during the commissioning of the tritium recovery facility. The levels at the Pickering station were 8.5 to 80 times higher than a previous (1986) survey. Although these increases are not proportional to the reported 2.7 fold increase in annual tritium emissions to atmosphere from this facility between 1986 and 1989, they do confirm higher and more extensive terrestrial tritium concentrations in the vicinity of the facility. Some possible reasons for the lack of agreement between the emission data and the grass sampling results are discussed in the report.

An analysis by AECB of the sampling results for the Pickering area from a health exposure basis indicated that there were too few samples for a valid risk assessment: however, based on other monitoring and emission data and a worst case scenario, the AECB have indicated that emissions from the Pickering Facility are well below population exposure limits and that there is no health concern.

# 6 Appendices

## 6.1 References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